



Nanoscale Devices and System Architecture

Opportunity

New concepts and design methods are needed to create new nanoscale devices, assemble them into functional systems, and create architectures compatible with various operational environments.

Priorities

Research in this area includes the development of (a) new tools and techniques for sensing, manipulating, and assembling; (b) architectures that integrate across multiple length scales; (c) software for automated design of specialized nanosystems; and (d) design automation tools for assembling large numbers of heterogeneous nanocomponents into a system.

Research Example of a Nanoscale Device: Molecular Transistor (supported by NSF)

Researchers at Cornell University have demonstrated a transistor-like device with the principal functional element being just one molecule (Figure 5). The device is fabricated from two gold electrodes separated by a very narrow gap that is bridged by a single molecule containing a cobalt atom. The flow of electrons from one electrode to the other, which occurs by an electron hopping on and off the cobalt atom, is controlled by the voltage on a third electrode near the bridging molecule. The electrical characteristics of the transistor can be varied by making chemical changes to this molecule, such as lengthening the molecule's connecting "arms." This research demonstrates that electron devices ~10,000 times smaller than present devices are possible.

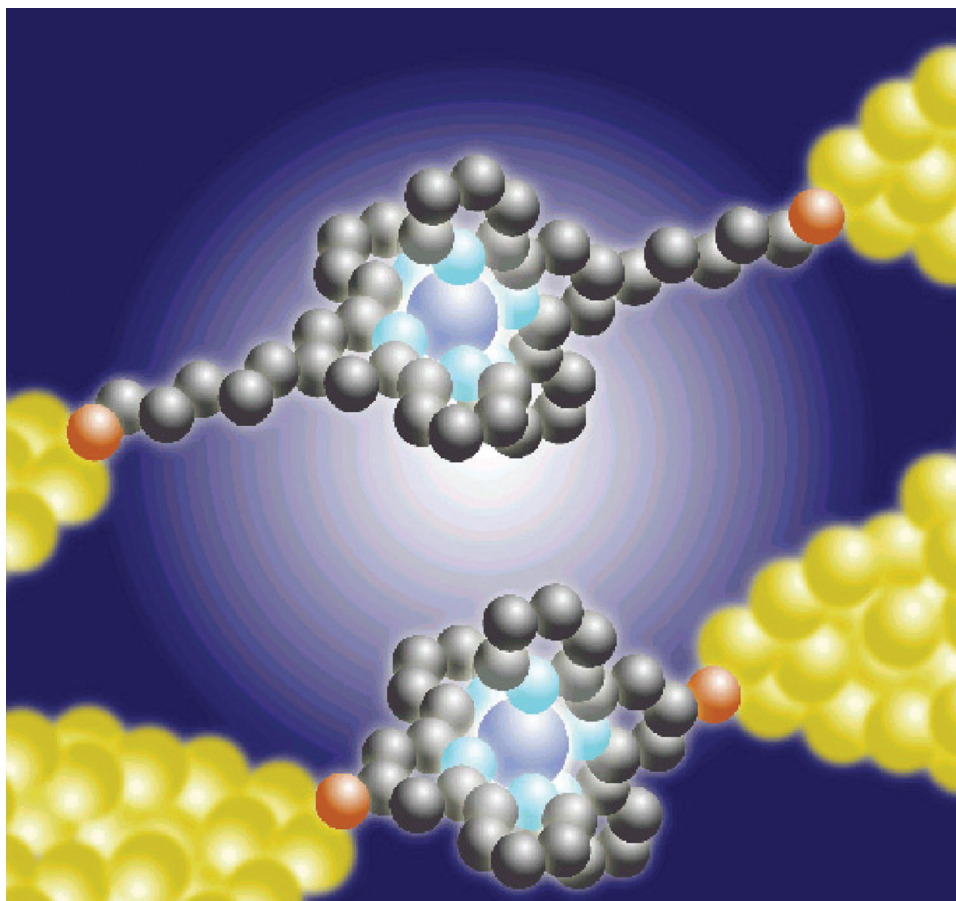


Figure 5. Artist's rendition of a molecular transistor ~10,000 times smaller than present devices. The flow of electrons (current flow) through the molecule bridging between the two gold electrodes is controlled by the voltage on a third electrode, not shown. The electric field from the third electrode determines the rate electrons can hop on and off a cobalt atom (dark blue) in the bridging molecule. The well-defined and deliberately designed molecular configuration is attached to the gold electrodes by sulfur atoms (red) (courtesy P. McEuen, Cornell University).